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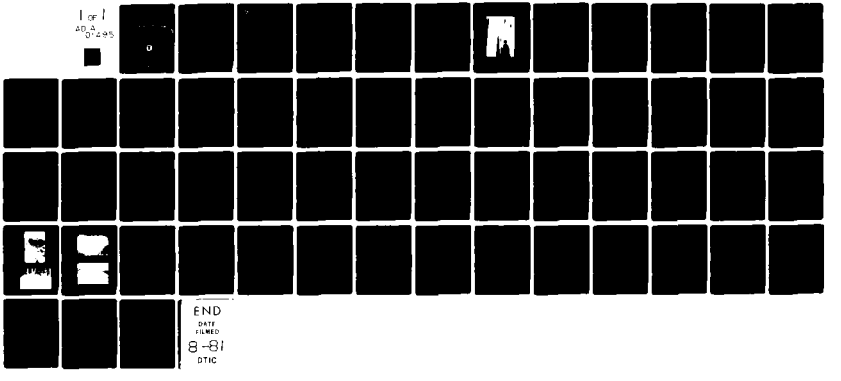

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National Dam Safety Program. Seneca Lake Dam (NJ00768), Delaware River Basin, Lubbers Run, Sussex County, New Jersey. Phase 1 Inspection Report.

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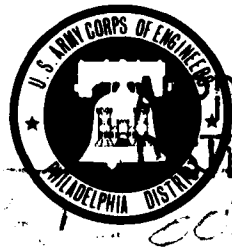
PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

REPT. NO. DAEN NAP-53842/NJ00768-81/06

JUNE 1981

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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READ INSTRUCTIONS BEFORE COMPLETING FORM

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Approved for public release; distribution unlimited.

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18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	National Dam Safety Program
Embankments	Seneca Lake Dam, N.J.
Visual Inspection	Spillways
Structural Analysis	Erosion

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
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IN REPLY REFER TO

NAPEN-N

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

6 JUL 1981

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Seneca Lake Dam, Sussex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Seneca Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to seven percent of the One Hundred Year Flood would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The leaking outlet pipe should be repaired within thirty days from the date of approval of this report.

b. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

c. Within twelve months from the date of approval of this report the following remedial actions should be initiated:

(1) Remove heavy brush from the downstream embankment and fill and resod the eroded areas, animal burrows, and settlement on the backslope and dam crest.

(2) Repair spalled and cracked concrete at the spillway apron.

NAPEN-N
Honorable Brendan T. Byrne

(3) Repoint the spillway masonry sidewalls.

(4) Operate the blow-off valve periodically to ensure its proper functioning and keep the intake area free of excessive siltation. It is further recommended that the blow-off valve be opened and additional water released in anticipation of, or during, severe storms.

d. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

e. An emergency action plan should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

for Kenneth R. Moser, Maj, CE, DC
JAMES G. TON
Colonel, Corps of Engineers
Commander and District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

SENECA LAKE DAM (NJ00768)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 4 February 1981 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Seneca Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to seven percent of the One Hundred Year Flood would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The leaking outlet pipe should be repaired within thirty days from the date of approval of this report.

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(2) Repair spalled and cracked concrete at the spillway apron.

(3) Repoint the spillway masonry sidewalls.

(4) Operate the blow-off valve periodically to ensure its proper functioning and to keep the intake area free of excessive siltation. It is further recommended that the blow-off valve be opened and additional water released in anticipation of, or during, severe storms.

d. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

e. An emergency action plan should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

APPROVED: Kenneth R Moser Maj CE DC
for JAMES G. TON
Colonel, Corps of Engineers
Commander and District Engineer

DATE: 1 July 1981

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Seneca Lake Dam Fed ID # NJ 00768

State Located	New Jersey
County Located	Sussex
Coordinates	Lat. 4100.0 - Long. 7438.9
Stream	Lubbers Run
Date of Inspection	February 4, 1981

ASSESSMENT OF GENERAL CONDITIONS

Seneca Lake is considered to be in a generally fair overall condition although its spillway capacity is inadequate and can accommodate only 6% of the 100-year design flood. It is recommended that the hazard classification be downgraded to significant since there are no homes immediately downstream although recreational facilities and an inn near the left abutment could be damaged in the event of a dam failure. While more precise hydraulic and hydrologic studies should be undertaken in the future to determine the feasibility of increasing the spillway capacity and the need for and type of mitigating measures necessary, the outlet pipe requires immediate repair. Other remedial measures to be undertaken in the future include the repair of the concrete at the spillway, removal of brush from the embankment, completion of the riprap work in progress on the upstream slope of the dam, repair of the eroded and settlement areas and filling of the burrows on the embankment. It is further recommended that the owner develop an emergency action plan and warning system to reduce the downstream hazard potential.

Abraham Perera P.E.
Project Manager

February ,1981

Overview of Seneca Lake Dam

TABLE OF CONTENTS

FIGURES

APPENDIX

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines can be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I investigations is to identify expeditiously those dams that may pose hazards to human life or property. The assessment of the general condition of the dam is based on available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In the review of this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway test flood is based on the estimated "probable maximum flood" for the region (greatest reasonable possible storm runoff) or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: SENECA LAKE DAM FED # NJ 00768

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Seneca Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Seneca Lake Dam is a 200-foot-long curved earthen structure with a concrete spillway at the right abutment. The embankment has a maximum height of 13 feet and a variable crest width ranging from 15 to 47 feet. The dam has a 1.5H:1V downstream slope and is somewhat arcuate in the plan view. The right half of the embankment strikes in a north-south direction, while the left half strikes S 40° E from the center to the east end of the dam. The concrete spillway is 19 feet wide with 2.25 foot high masonry side walls. A wooden foot bridge extends across the weir, and 9-inch-high flashboards restrict the clear opening beneath the bridge's soffit to 1.5 feet. The spillway is essentially flat for a distance of 30 feet downstream of the flashboards where a 3.5-foot stepdown is located. A 12-inch-diameter CMP drain is located about 50 feet from the left abutment of the dam at exit invert 847.5.

b. Location

The dam is located at the headwater of Lubbers Run approximately 200 feet north of the intersection of Seneca Lake and Tomahawk Lake roads in Sparta Township, Sussex County, New Jersey.

c. Size Classification

The dam at Seneca Lake has a maximum height of 13 feet and a maximum storage capacity of 96.6 acre-feet. Accordingly, this dam is in the small size category as defined by the criteria in the Recommended Guidelines for Safety Inspection of Dams (storage less than 1,000 acre-feet and height less than 40 feet).

d. Hazard Classification

The dam is located in a relatively undeveloped valley in the Sparta Mountains. While residential construction is increasing in the valley, development is presently along the hillsides out of the path of flood hazard. However, there is an inn located at the junction of the dam and the left abutment that could be extensively damaged if a dam breach occurred at that point. In addition, the stream channel passes under a local road about 200 feet downstream of the dam. Both the road and a pump house, located within 50 feet of the stream and road intersection, could be damaged by flood flows. Although the dam height is low and the downstream area is relatively flat, paths in the area between the dam and the road indicate heavy foot traffic and children playing in this area near the outlet channel immediately downstream of the dam could be endangered in the event of a sudden failure. Moreover, a lake 300 yards downstream is a popular public recreational area during the summer months, and the wooded area between the two lakes could be a source of recreation for children at any given time during the summer. Accordingly, it is recommended that Seneca Lake Dam be placed in the significant hazard classification.

e. Ownership

The western half of the dam is owned by the Seneca Lake Beach Association, P.O. Box 505, Sparta, New

Jersey, 07871. The president of the association, Mr. Jim Dickey, can be contacted at phone number: 201-729-3484. The remainder of the dam is owned by Chester Wallace, whose address is 401 Outwater Lane, Garfield, New Jersey, 07026.

f. Purpose of Dam

The purpose of the dam is recreation.

g. Design and Construction History

No information is available regarding the design or construction history of the dam.

h. Normal Operating Procedures

Operating procedures at the dam are limited to lowering the lake once a year in the fall in order to perform routine maintenance on the dam, its spillway, and the intake to the low level drain.

1.3 PERTINENT DATA

a. Drainage Area

Seneca Lake Dam has a drainage area of 1.8 square miles that consists primarily of sparsely developed woodlands.

b. Total spillway capacity at maximum pool elevation is 112 cfs.

c. Elevations

Top of dam	-	856.50
Spillway crest w/flashboards	-	855.00
Spillway crest w/o flashboards	-	854.25
Streambed at centerline of dam	-	843.50

d. Reservoir

Length of maximum pool (top of dam)	- 1670 feet
Length of recreation pool (spillway crest)	- 1600 feet

e. Storage (acre-feet)

Top of dam - 96.6
Recreation pool - 58.2

f. Reservoir Surface (acres)

Top of dam - 28.2
Recreation pool - 23.0

g. Dam

Type - Earth with concrete spillway at right abutment

Length - 200 feet

Height - 13 feet

Top width - Variable: 15-47 feet

Side slopes - 1.5H:1V downstream; upstream unknown

Zoning - Unknown

Impervious blanket - Unknown

Corewall - Unknown

Cutoff - Unknown

Grout curtain - Unknown

h. Diversion and Regulating Tunnel

Type - None

i. Spillway

Type - Broad-crested concrete weir at right abutment

Weir length - 19 feet

Gates - 9-inch-high flashboards

U/S channel - Shallow, sandy-bottomed channel.

D/S channel - Concrete lined, 30-foot-long, positively sloped channel that steps down 3.5 feet to a natural stone-filled channel.

j. Regulating Outlets

A 12-inch-diameter, gate operated, CMP is located 50 feet from the left abutment at outlet invert elevation 847.5. This pipe appears to function as a low level drain.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No information was available regarding the Dam Application, design details, or the exact period when the dam was constructed. The NJDEP does not have microfilm records regarding this structure or a Dam Application number.

2.2 CONSTRUCTION

No information was available.

2.3 OPERATION

See Section 4.

2.4 EVALUATION

a. Availability

While nothing is known regarding the original design and construction of the dam, information pertaining to the geology of the area was obtained from the Geologic Map of New Jersey and regional engineering soil surveys. The dam is located in a narrow bedrock valley that is overlain by glacial drift and alluvium. The overburden consists of silty sands and gravels with an appreciable number of cobbles and boulders. The bedrock underlying the dam is Precambrian losee gneiss, a hard, dense rock that exhibits a well-developed joint system. The bedrock is near the ground surface immediately to the east and west of the dam.

b. Adequacy

In view of the modest height of the dam and its condition as observed in the field (see Section 3) the information gathered is believed adequate to perform the assessment contained hereafter.

c. Validity

No meaningful statement can be made, as there is a complete absence of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspection of Seneca Lake Dam was performed on February 4, 1981, at which time about an inch of water was passing over the spillway flashboards and 2 inches of water were issuing from the low level drain pipe, indicating that the valve is at least partially open. The dam appears to be in a generally fair condition, although the downstream embankment needs some cosmetic landscaping and a rather substantial leak was noted at the downstream toe.

b. Dam

The dam's embankment is in fair condition and exhibits signs of recent remedial work on the upstream side of the crest. Brush has been removed from the crest and stone has been placed at the water line for a distance of about 50 feet from the spillway. The remainder of the upstream edge of the crest exhibits signs of light wave erosion. The downstream slope of the embankment is covered with thickets and heavy brush and animal burrows were observed near the center of the slope. The crest width of the dam is very irregular, ranging from 47 feet near the spillway to 15 feet on the right side of the outlet pipe and, a few inches of settlement was observed in localized areas at the wider portion of the crest. Some erosion was noted on the downstream slope near the outlet pipe. Apparently, foot traffic contributes to this condition. In addition, a fairly substantial leak was observed 13 feet to the right of the pipe at the toe of the dam. Calculations based on the width, depth, and velocity of flow indicate that the leak is discharging 30 to 40 gallons per minute. Additional leakage, observed emanating from around the outside of the outlet pipe, was determined to be the result of a hole in that pipe. Since the hole is located about six feet from the outlet end of the pipe, the leak only occurs when the gate valve is open. A heavy seep was observed about 15 feet left of the outlet pipe at the toe of the dam. It appears as if this condition may have been a more substantial leak in the past since a

well-defined channel originates at this location and parallels the outlet pipe channel for a distance of 65 feet. The shallow seepage channel is slightly higher in elevation than the outlet pipe channel and is covered with damp, decaying leaves and other vegetation. Several boulders, weighing in excess of 1 ton, have been placed at the source of the seep in what was an apparently successful attempt to mitigate the effects of a more serious problem. While the leak emanating from around the outlet is the result of a hole in the pipe, the source of the large leak and the seep are less certain. Since foundation and internal conditions of the dam are unknown, it is uncertain if the flows are ground water upwelling from under the dam, seepage and leakage through or at the base of the dam, or lateral movement of ground water from the spillway channel or toe drains if such exist.

c. Appurtenant Structures

The spillway and side walls are in fair overall condition, although some concrete deterioration, consonant with the age of the structure, was noted. Spalling and cracking of the spillway slab was observed and a horizontal crack (cold joint) extending the width of the slab was noted at the 3.5-foot step at the end of the apron. While general concrete rehabilitation and repointing of the masonry sidewalls would improve the aesthetics and flow properties of the spillway, these repairs are not critical to the integrity of the structure and can be undertaken sometime in the future.

d. Reservoir

The lake is bounded on the east and west by relatively steep, heavily forested slopes with only light residential development in evidence around the southern end of the lake and Seneca Lake Road. The upper portion of the watershed has more gradual slopes and slightly denser development along the nothern fringe. Observations of the lake were hampered by ice at the time of the inspection, but it appeared free of debris and other obstructions. The approach channel to the spillway appeared very

shallow with a sandy bottom. This is due to the creation of a bathing beach immediately adjacent to the right abutment of the spillway. Normal currents flowing to the spillway are transporting beach sand to the weir where it is deposited immediately in front of the flashboards. Water was issuing from the 12-inch CMP at the time of the inspection. The pipe, which appeared in satisfactory condition, had no outlet structure but seemed to be supported on large stones. The leak at this location emanates from a hole between the pipe and the stone. Communication with a representative of the owner indicated that the valve was opened last year to drain the lake so that repairs could be made to the dam. Apparently the valve was not closed after the work was completed, since it froze in an open position.

e. Downstream Channel

Discharge from the spillway flows down a natural, stone-laden channel that curves around the right end of the dam to a point where it is joined by the outlet pipe channel. The combined flows continue to a road culvert about 200 feet beyond the toe of the dam. The opening of the box culvert is 5 feet by 8 feet but would not present a constriction to very heavy flows since there is a saddle in the road, adjacent to the culvert, which would act as a spillway if water began to pile up against the road. The channel gradient and side slopes flatten out on the downstream side of Seneca Lake Road since the valley widens somewhat before the channel encounters Tomahawk Lake about 300 yards beyond the culvert.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The dam functions essentially unregulated throughout the year. Each year, in the fall, the association gets permission from the State Fish and Game Division to lower the lake for maintenance and dock repairs. The lake level remains down until March, at which time the lake is allowed to refill to normal pool elevation. No other operational procedures are practiced as a matter of routine; however, members of the association are available to lower the lake level should extraordinary circumstances dictate such an action.

4.2 MAINTENANCE OF DAM

Maintenance of the dam and spillway is reportedly performed by members of the lake association, but work accomplished is generally limited to light landscaping and debris removal from the spillway, drain inlet, or downstream channel. According to association representatives, a maintenance program currently in effect will, when completed, see the entire upstream side of the dam crest lined with rip rap in the zone of wave action.

4.3 MAINTENANCE OF OPERATING FACILITIES

As indicated in paragraph 4.2, maintenance of the drain is usually performed by members of the lake association. At present, this work is generally limited to cleaning debris and silt from the entrance and within the low level drain, checking the operation of the gate valve each year, and inspecting visible portions of the pipe for obvious defects or conditions requiring repairs.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

No formal warning system exists at Seneca Lake, although members of the association make periodic inspections of the dam and spillways.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

In view of the limited regulatory facilities present at the dam, the existing operational procedures are considered satisfactory. The employment of a regular periodic maintenance program is considered laudable. However, it is felt that the association should direct its maintenance efforts

in the immediate future toward the, apparently, more serious leakage problems at the toe of the dam. In addition, the association should develop an emergency action plan and warning system to minimize the potential downstream flooding hazards.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

Pursuant to the Recommended Guidelines for Safety Inspection of Dams, Seneca Lake Dam is a small size and significant hazard. Accordingly, the 100-year frequency storm was chosen as the design flood by the inspecting engineers. Inflow to the reservoir for the selected storm was calculated utilizing precipitation data from Technical Paper 40 and Technical Memo NWS Hydro-35 in conjunction with the HEC-1 computer program. A peak inflow of 2,033 cfs was computed which, when routed through the reservoir, reduced the peak discharge to 1,796 cfs. As the spillway capacity with the flashboards in place is 112 cfs, it can accommodate only 6% of the 100-year flood and is inadequate.

b. Experience Data

There are no streamflow records available for this site, nor have records been kept regarding the dam's hydraulic performance since its construction.

c. Visual Observations

At the time of inspection, the lake was completely frozen but water was still running over the weir. The flashboards were in place and it appears that little freeboard exists between the water surface elevation and the top of the dam, although no sign of overtopping in the recent past was observed.

d. Overtopping Potential

Employing the discharge and spillway capacities contained herein, overtopping of 2.1 feet would occur in the event of the 100-year frequency storm. However, there are no records or indications that the dam has ever been overtopped.

e. Drawdown

To dewater the lake, the gate valve for the 12-inch CMP would have to be opened. Drawdown is possible to elevation 847.5, and would take approximately 10 days to accomplish.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

No deficiencies of a structural nature were noted during the inspection of this dam. The crest is relatively uniform in a horizontal plan and, although the width of the dam crest is extremely variable, the maximum height-to-width ratio is conservatively modest (0.87). No indications of mass movement of material, sloughing, or cracking, were noted, although there appears to be a few inches of settlement in a small (2' x 6') localized area on the crest. In addition, the leak observed to the right of the outlet pipe requires monitoring to ensure that piping through the dam does not develop.

b. Design and Construction Data

As indicated in Section 2, no information is available regarding the design or construction history of the dam.

c. Operating Records

While no formal operating records are maintained by the lake association, the dam appears to have performed satisfactorily since its construction.

d. Post Construction Changes

The only modification at the dam appears to be the addition of a 9-inch-high flashboard to the spillway weir. Based on the USGS quadrangle map of the area, the flashboard was installed sometime between 1954 and 1971.

e. Seismic Stability

Seneca Lake Dam is located in Seismic Zone 1, where seismic activity is slight and additional structural loading imparted thereby is generally insignificant. Experience indicates that earthen dams in Zone 1 that are stable under static loading

conditions will maintain their structural integrity when subjected to the negligible dynamic loads imposed by the weak seismicity characteristic of this area. Since Seneca Lake Dam is considered stable under the existing static conditions, it is presumed the dam will maintain its structural integrity if subjected to seismic loading.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL ACTIONS

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, Seneca Lake Dam is judged to be in a fair overall structural condition. However, the spillway is capable of accommodating only 6% of the 100-year frequency design flood with the flashboards in place. The spillway capacity can be increased to 205 cfs, or 11% of the design flood by providing for removal of the flashboard during periods of high inflow. While some dam overtopping could be tolerated without serious consequences because of the low height of the dam and its high crest width-to-height ratio (which ranges form 1.2:1 to 7.8:1), a more immediate problem is the leak observed at the toe of the downstream slope. It is recommended that this dam be placed in the significant hazard category because the area downstream of the dam is a source of recreation for local children and tourists during the summer months.

b. Adequacy of Information

With the exception of visual observations, no information was available for use in evaluating the condition of this dam. The lack of data pertaining to the composition and construction of the dam makes evaluation of the leakage at the toe of the dam difficult. Accordingly, the leaks should be monitored closely.

c. Urgency

While implementation of the recommendations pertaining to routine maintenance may be undertaken in the future, it is felt that monitoring of the leak and repair of the outlet pipe should begin immediately.

d. Necessity for Further Study

It is recommended that more precise hydraulic and hydrologic investigations be undertaken to refine the magnitude of the design flood and spillway calculations, and, to determine the need for, and

type of, mitigating measures that may be required. In addition, the extent and nature of remedial work required to correct the leak at the outlet pipe should be investigated.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommendations

It is recommended that monitoring of the leaks and repair of the outlet pipe begin immediately. It is further recommended that studies be undertaken in the future to determine the feasibility of permanently increasing the spillway capacity. In the interim, provisions should be made to have the flashboard removed during periods of high flow at the spillway. These provisions should include the attachment of handles to the flashboard to facilitate its removal.

b. O&M Maintenance and Procedures

It is recommended that the association's existing maintenance program be continued and expanded to include removal of the heavy brush from the downstream embankment and filling and resodding the eroded areas, animal burrows, and settlement on the backslope and dam crest. The concrete spalling and cracking at the spillway apron should be undertaken in the future, as should the repointing of the spillway masonry sidewalls. It is recommended that the blow-off valve be opened periodically to ensure its proper functioning and keep the intake area free of excessive siltation. It is further recommended that the blow-off valve be opened and additional water released in anticipation of, or during, severe storms. The owners should develop an emergency action plan and downstream warning system to minimize the potential for flood damage downstream.

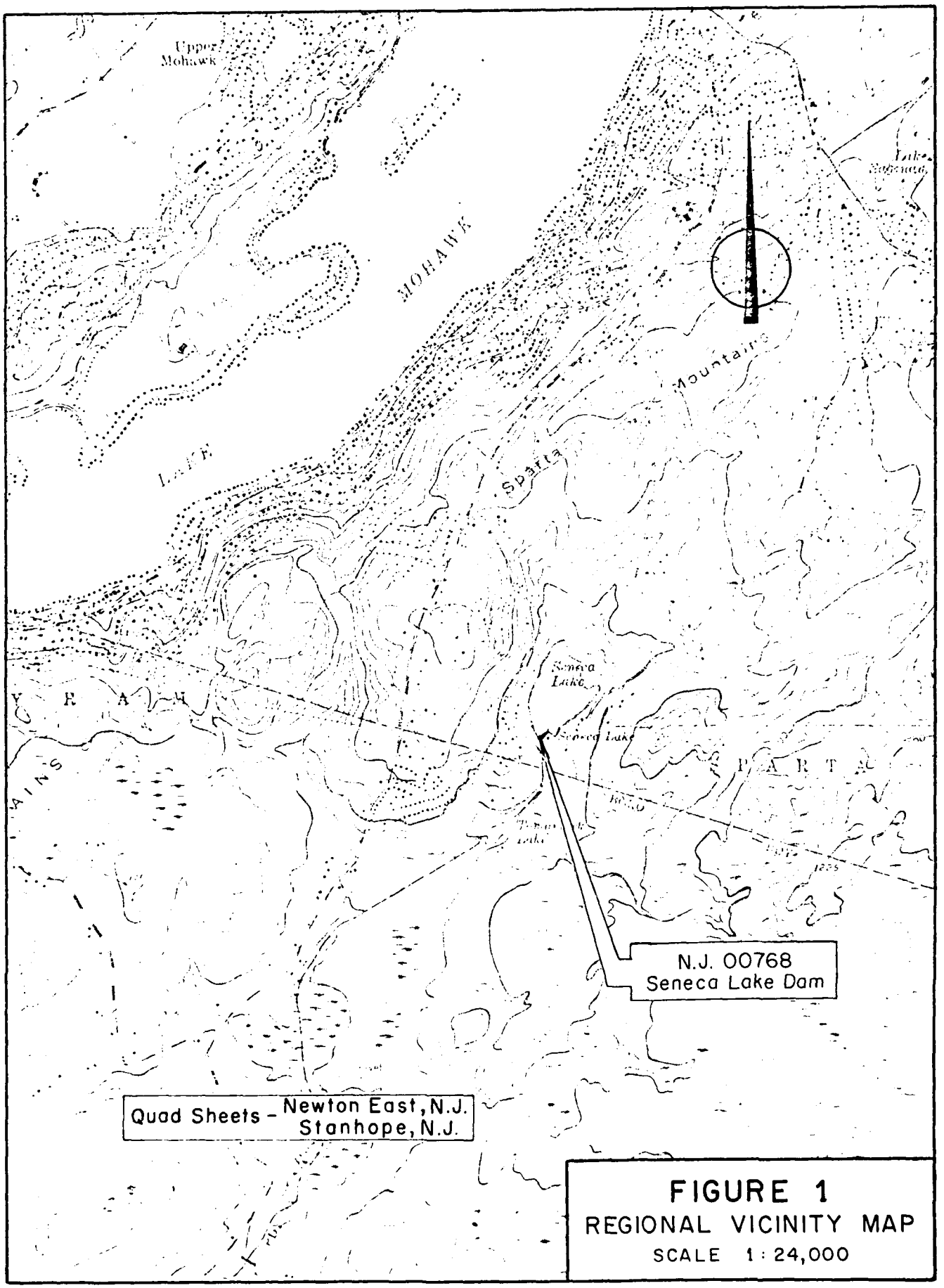
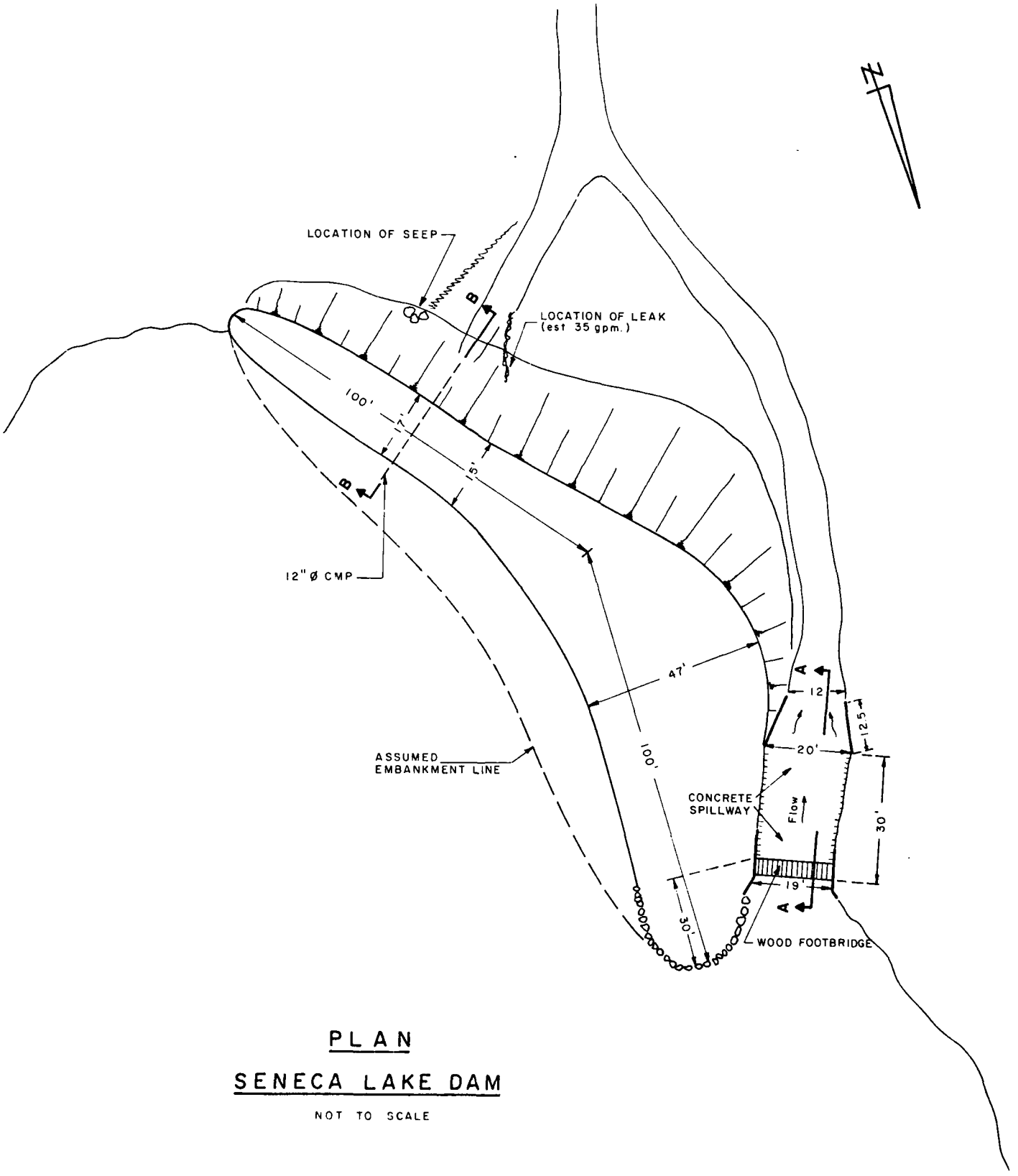


FIGURE 1
REGIONAL VICINITY MAP
SCALE 1 : 24,000

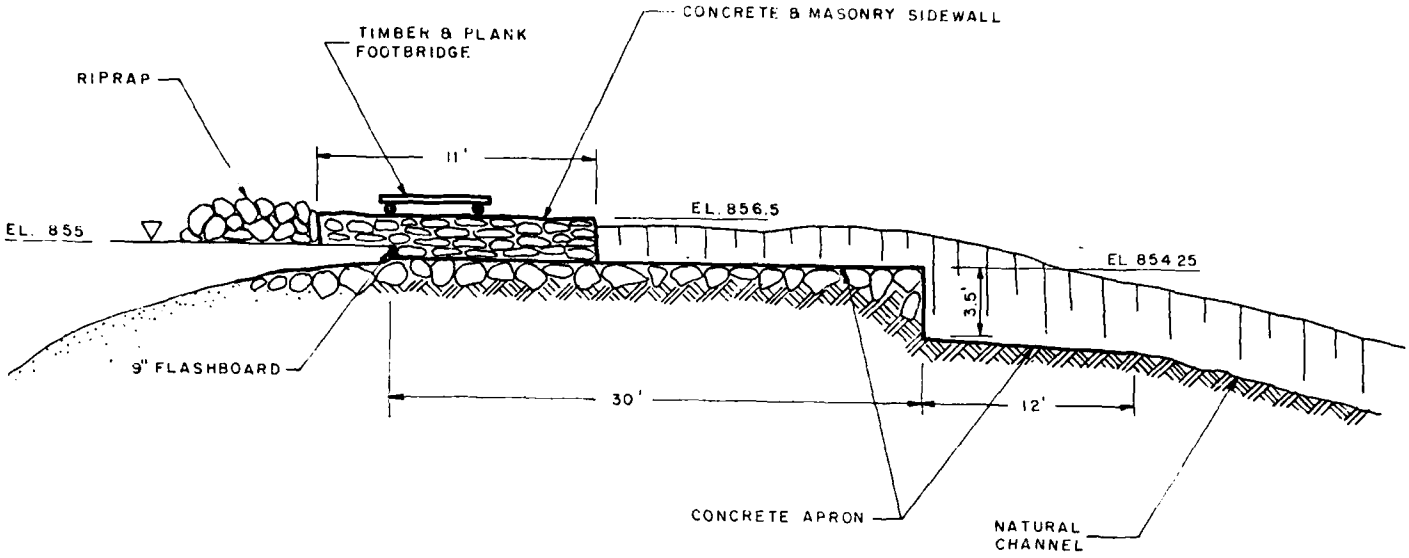


PLAN

SENECA LAKE DAM

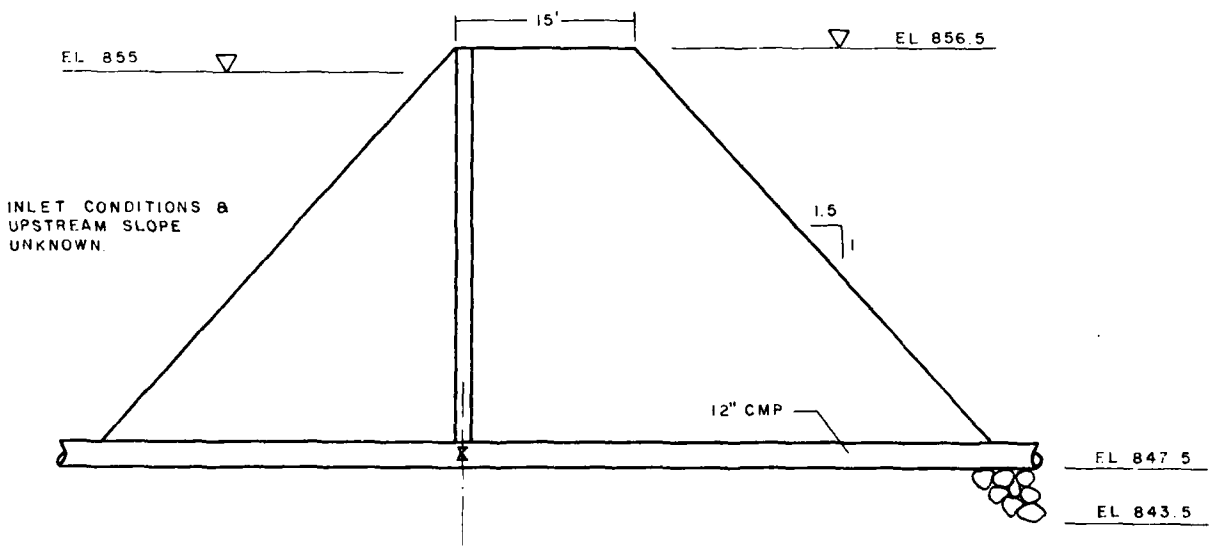
NOT TO SCALE

FIGURE 2



SPILLWAY SECTION A-A

NOT TO SCALE



TYPICAL DAM SECTION B-B

SHOWN SCHEMATICALLY - NOT TO SCALE

SENECA LAKE DAM

FIGURE 3

Check List
Visual Inspection
Phase 1

Name Dam Seneca Lake Dam County Sussex State New Jersey Coordinators NJDEP

Date(s) Inspection 2/4/81 Weather Overcast Temperature 15°F

Pool Elevation at Time of Inspection 855 M.S.L. Tailwater at Time of Inspection 842 M.S.L.

Inspection Personnel:

T. Chapter J. Ceravalo

A. Perera

J. Greenstein

No representative of owner present.

A. Perera Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Light erosion downstream near the outlet pipe. Irregular crest line upstream probably due to wave action.	Eroded areas on both slopes should be filled and regraded. Upstream slope should be protected by addition of riprap.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Crest of dam fairly uniform and flat. Alignment is curved (arc) as constructed.	Width of crest varies considerably (see plan of dam).
RIPRAP FAILURES	No riprap on upstream slope except near spillway (see plan of dam). Large boulders at downstream toe near outlet pipe.	Apparently placed to halt erosion occurring near heavy seep.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Downstream slope overgrown with trees and brush.	Should be cleared and regraded
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Embankment grades smoothly into abutments.	
ANY NOTICEABLE SEEPAGE	1. Seepage at toe of dam about 35' from left abutment. 2. Leak at downstream toe of dam about 63' from left abutment. 3. Leakage occuring under 12" CMP.	Heavy boulders placed in area of seep. Flow from leak estimated to be 35 gal./min. Leak should be monitored, source determined, and condition corrected.
STAFF GAGE AND RECORDER	None.	
DRAINS	12" CMP 50' from left end of dam	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None.	
INTAKE STRUCTURE	Not observed.	
OUTLET STRUCTURE	None.	
OUTLET CHANNEL	Natural wooded channel to road culvert about 200 feet downstream. Channel widens on far side of road before entering Tomahawk Lake about 300 yards downstream from road.	Channel side banks about 2' high with variable side slopes.
EMERGENCY GATE	Valve on 12" pipe open at time of inspection.	Flow about 2" deep in pipe.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete weir 19' wide w/9" flashboards. Broad crested weir is 30' long with a 3.5' step down to a concrete apron that slopes to the bouldery downstream channel	Concrete in poor condition, Spalled and cracked. Concrete and masonry side walls deteriorating. All concrete work at the spillway needs rehabilitation.
APPROACH CHANNEL	Not seen due to ice. Appears to be a gently sloping, sandy bottom.	
DISCHARGE CHANNEL	1. Between dam and downstream culvert: 12' wide stone bottom; height of banks 2'; right slope 5:1; left slope 4:1; heavy vegetation. 2. At downstream culvert: embankment slopes 3.5' high, heavy growth above banks. 3. Downstream of culvert: channel flattens and widens.	Channel capacity appears adequate to accommodate maximum discharges.
BRIDGE AND PIERS	Wooden foot bridge over spillway. Clear opening of 18" between top of flashboards and timber soffits.	Bridges does not constrict flow until dam is overtopped.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Heavily wooded w/light development. Surrounding hills slope about 2:1 to lake.	
SEDIMENTATION	Ice precluded estimation of amount of silt in lake.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Wooded, bouldery stream channel to road culvert about 200 feet downstream. Culvert has 5' x 8' clear opening. Downstream of road the flood plain widens and become more densely forested before reaching the next lake about 300 yards downstream.	
SLOPES	Slopes of channel banks very variable and about 2' -3' high. Ground surface becomes flatter beyond channel banks and below downstream culvert.	
APPROXIMATE NO. OF HOMES AND POPULATION	No homes immediately downstream. Roads and downstream picnic area appear to be in flood path.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Not Available
REGIONAL VICINITY MAP	USGS Quadrangle
CONSTRUCTION HISTORY	Not Available
TYPICAL SECTIONS OF DAM	Not Available
HYDROLOGIC/HYDRAULIC DATA	Not Available
OUTLETS - PLAN	Not Available
- DETAILS	
-CONSTRAINTS -DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	Not Available

ITEM	REMARKS
SPILLWAY PLAN	Not Available
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Not Available

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Not Available

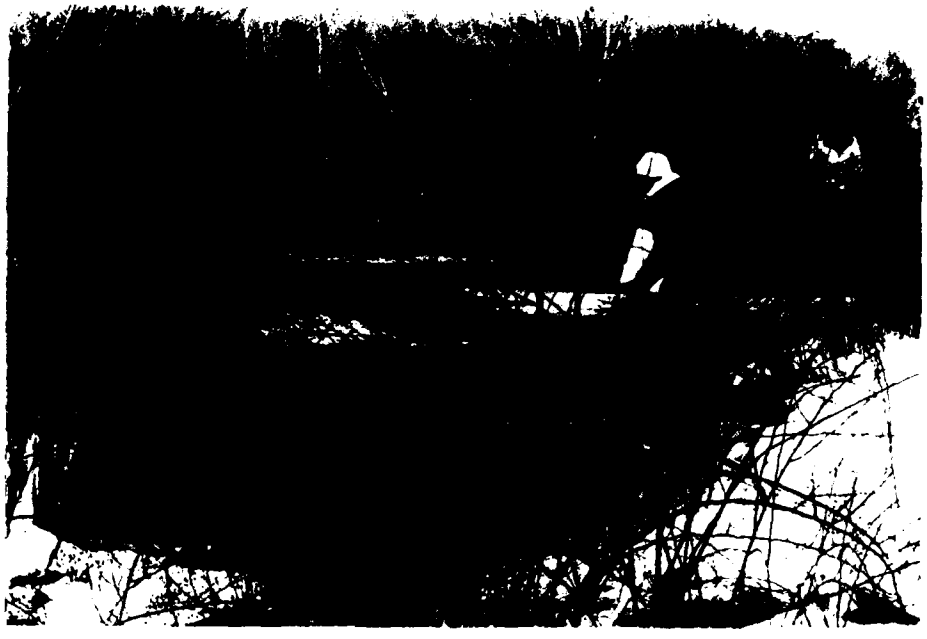
ITEM	REMARKS
MONITORING SYSTEMS	None observed
MODIFICATIONS	Not Available
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Not Available
MAINTENANCE OPERATION RECORDS	Not Available

February, 1981

View of CMP Outlet (Note leak in foreground)

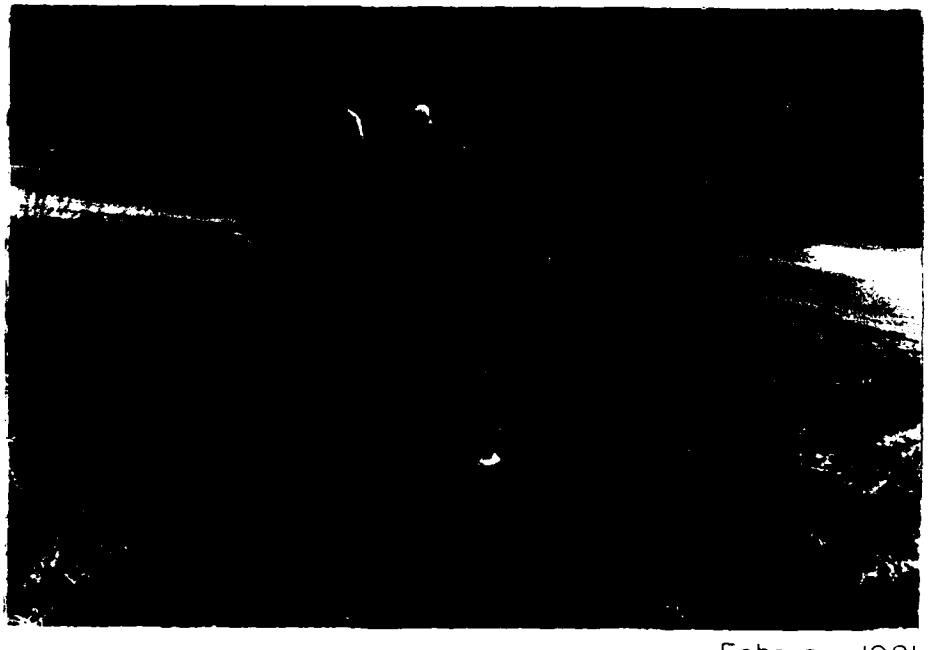
February, 1981

View of Seepage and Outlet Channel



February, 1981

View of Spillway and Footbridge



February, 1981

View of Downstream Road Bridge

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.8 sq. mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 855 MSL (58.2 ac. ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 856.5 MSL (96.6 ac. ft.)

CREST: Spillway

a. Elevation 854.25 MSL
b. Type Broad crested, concrete weir
c. Width 19 feet
d. Length 30 feet
e. Location Spillover Right abutment of dam
f. Number and Type of Gates Flashboard to elevation 855 MSL

OUTLET WORKS: Low Level Drain

a. Type Gate operated CMP
b. Location 50 feet from left abutment
c. Entrance inverts Unknown
d. Exit inverts 847.5 MSL
e. Emergency draindown facilities Same

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 112 cfs; 205 cfs w/o flashboard.

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 14 OF 17

CHKD. BY _____ DATE _____ PROJECT CC-276

SUBJECT _____

BY [illegible] DATE [illegible] **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. [illegible] OF 61

CHKD. BY ______ DATE ______ [illegible] PROJECT [illegible]

SUBJECT [illegible]

[illegible]

[illegible] 650 [illegible]

134

[illegible]		Dimensionless [illegible]	[illegible] (q_p [illegible])
[illegible]	[illegible]	.061	45
[illegible]	[illegible]	[illegible]	159
[illegible]	[illegible]	.532	346
	[illegible]	[illegible]	547
	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	.965	629
[illegible]	[illegible]	.931	549
[illegible]	[illegible]	.867	[illegible]
[illegible]	1.6[illegible]	.504	38[illegible]
[illegible]	[illegible]	.385	250
[illegible]	2.1[illegible]	.300	195
3[illegible]	2.2[illegible]	[illegible]	148
[illegible]	2.[illegible]	.172	112
[illegible]	2.62	.127	83
3.[illegible]	2.[illegible]	.095	69
[illegible]	2.9[illegible]	.076	49
[illegible]	3.17	.062	40
[illegible]	3.35	.04[illegible]	31
		Σ	4630

[illegible] $\dfrac{4630 \times [\text{illegible}]}{[\text{illegible}]}$ = .9765 [illegible] 1.0 inch

BY _____ DATE _____ LOUIS BERGER & ASSOCIATES INC. SHEET NO. _____ OF _____

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SUBJECT _____

Precipitation data from TP-40 & NOAA Technical Memorandum NWS Hydro-35

Time	Precipitation	Δ	Rearranged Δ
0.25	1.66	1.66	0.06
0.50	2.30	0.64	0.07
0.75	2.70	0.40	0.07
1.00	3.00	0.30	0.08
1.25	3.25	0.25	0.09
1.50	3.44	0.19	0.10
1.75	3.60	0.16	0.11
2.00	3.75	0.15	0.13
2.25	3.89	0.14	0.15
2.50	4.02	0.13	0.19
2.75	4.14	0.12	0.30
3.00	4.25	0.11	0.64
3.25	4.35	0.10	1.66
3.50	4.45	0.10	0.40
3.75	4.54	0.09	0.25
4.00	4.63	0.09	0.16
4.25	4.71	0.08	0.14
4.50	4.79	0.08	0.12
4.75	4.87	0.08	0.10
5.00	4.94	0.07	0.09
5.25	5.01	0.07	0.08
5.50	5.08	0.07	0.08
5.75	5.14	0.06	0.07
6.00	5.20	0.06	0.06

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. _____ OF _____

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BY _____ DATE _____

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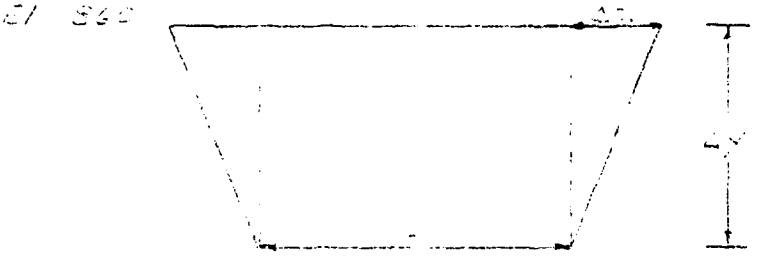
LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 46 OF 114

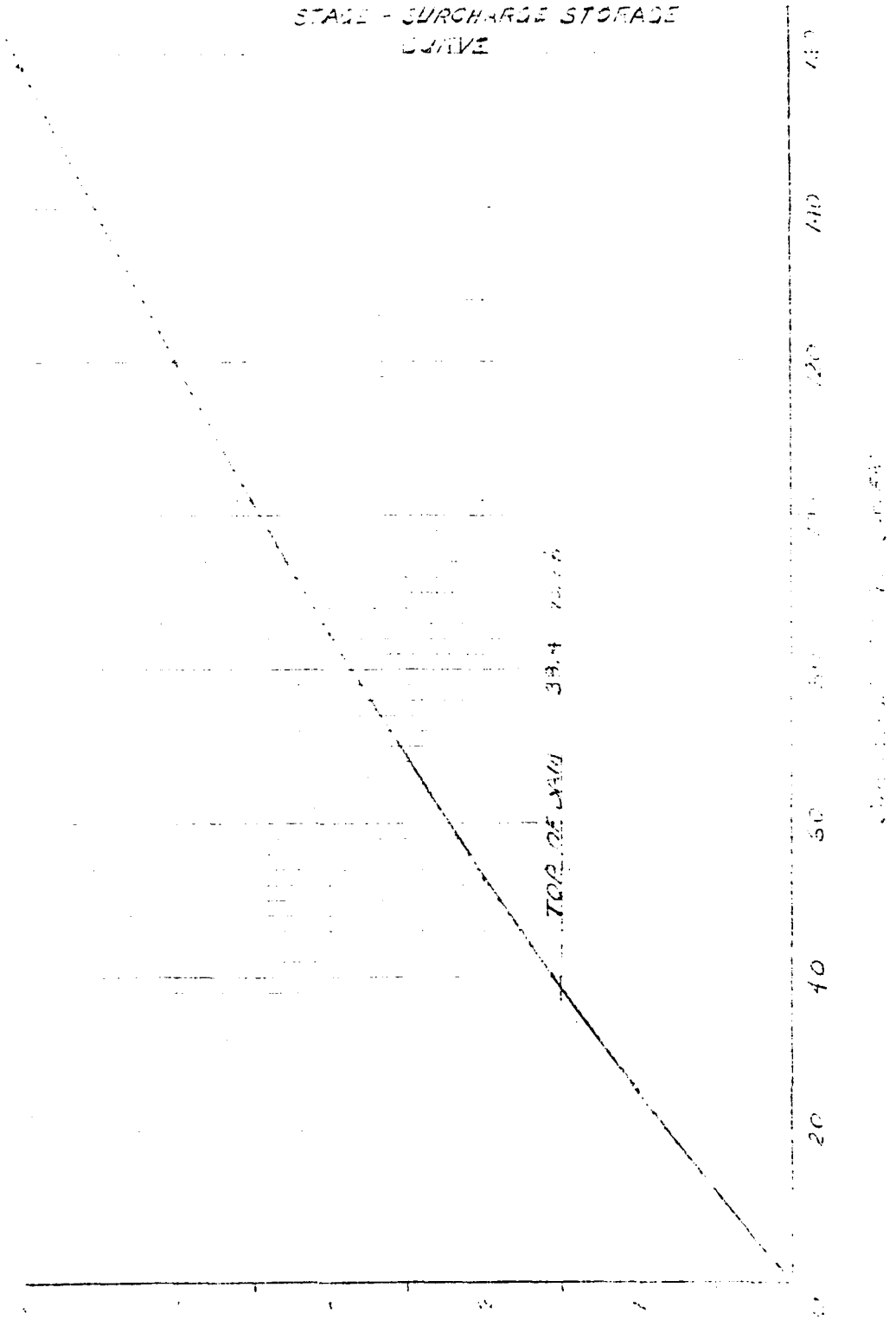
PROJECT _____



300	0	23	0
301	1	24.7	24.7
302	2	26.45	52.25
303	3	28.22	84.66
304	4	29.95	119.84
305	5	31.7	158.5

AT OF AI

STAGE - SURCHARGE STORAGE CURVE



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		Discharge	ELEV.
		(cfs)	M.S.L.
0	-	-	855
1	[illegible]	[illegible]	[illegible]
1.5	[illegible]	[illegible]	856.5
2.0	[illegible]	[illegible]	857.5
3	[illegible]	[illegible]	858.6
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	861.5
[illegible]	[illegible]	[illegible]	862.5

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CHKD. BY _____ DATE _____ PROJECT _____

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$$Q = A\sqrt{\frac{2g}{K_e}}$$

$A = 0.79$ sq. ft.

$H_{ave} = 7/2 = 3.5'$

$K_e = \Sigma K_c, K_e, K_o, K_i = 0.04 + 0.2 + 1.0 = 6.3$

$$Q = 0.79\sqrt{\frac{2(32.2)(3.5)}{6.3}} = 4.72 \text{ cfs}$$

$$Q = 0.79 \text{ cfs} \times 3 = 2.37 \text{ cfs}$$

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```
A1  SCHOHA DAM  HEC1DB
A2  J GERAVOLO
A3  FEB 20, 1981
I     1I0       0      15       0       0       0       0       0       0       0
I1      1
K       0       1                                       1
K1  INFLOW HYDROGRAPH TO RESERVOIR
M       2      -1     1.8                       0                               1
O      84
O1     06      07      07     .08     .09     .10     .11     .12     .13     .14
O1     .12     .10     .08     .07     .06     .05     .04     .03     .02     .01
T                                                       5       1
U      15
U1     45     159     346     540     606     629     640     435     328     291
U1    195     148     112      83      64      49      40      31
X                      1                                        1
X       1       2
K1  ROUTED FLOWS THROUGH RESERVOIR
Y                              1       1                                       -1
Y1      1
Y2    855     856     856.5   857.5   858.5   859.5   860.5   861.5
Y5      0      51     112      229     1696    2965    4456    6140
Y6      1    24.7    38.4     68.4    101.8   138.7   179.1   223.0
Z2    855     856     856.5   857.5   858.5   859.5   860.5   861.5
Z3    855
Z0  856.5
X       0
```

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPPT	MSTAN
100	0	15	0	0	0	0	0	0	0
			JOPER	NWT	LRPT	TRACE			
			2	0	0	0			

INFLOW HYDROGRAPH TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPPT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

LMSTR	TRSDA	TAREA	SNAP	TRSPA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	1.80	0.00	1.80	0.00	0.000	0	1	0

PRECIP PATTERN

0.06	0.07	0.07	0.08	0.09	0.10	0.11	0.13	0.15	0.14
0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01

LOSS DATA

STRTL	CNSTL	ALSMX	RTIMP
0.00	0.10	0.00	0.00

SUB-AREA RUNOFF COMPUTATION

PRECIP DATA

	PTOTA	BACU	DAC
24	1.10	2.10	0.00

[illegible] 15

[illegible]	640	629	640	435	328	300
	195	148	112	83	64	49	40	31

[illegible] 1.00 INCHES OVER THE AREA

PEAK-FLOW DATA

[illegible] 0.00 PTIOR= 1.00

PEAK	TIME	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ROUTING

IRES	METRD	AMSKK	STORA	X	TSK	STORA	ISPRAT
1	0	0.00	0.000	0.000	0.000	0	-1

PEAK 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME

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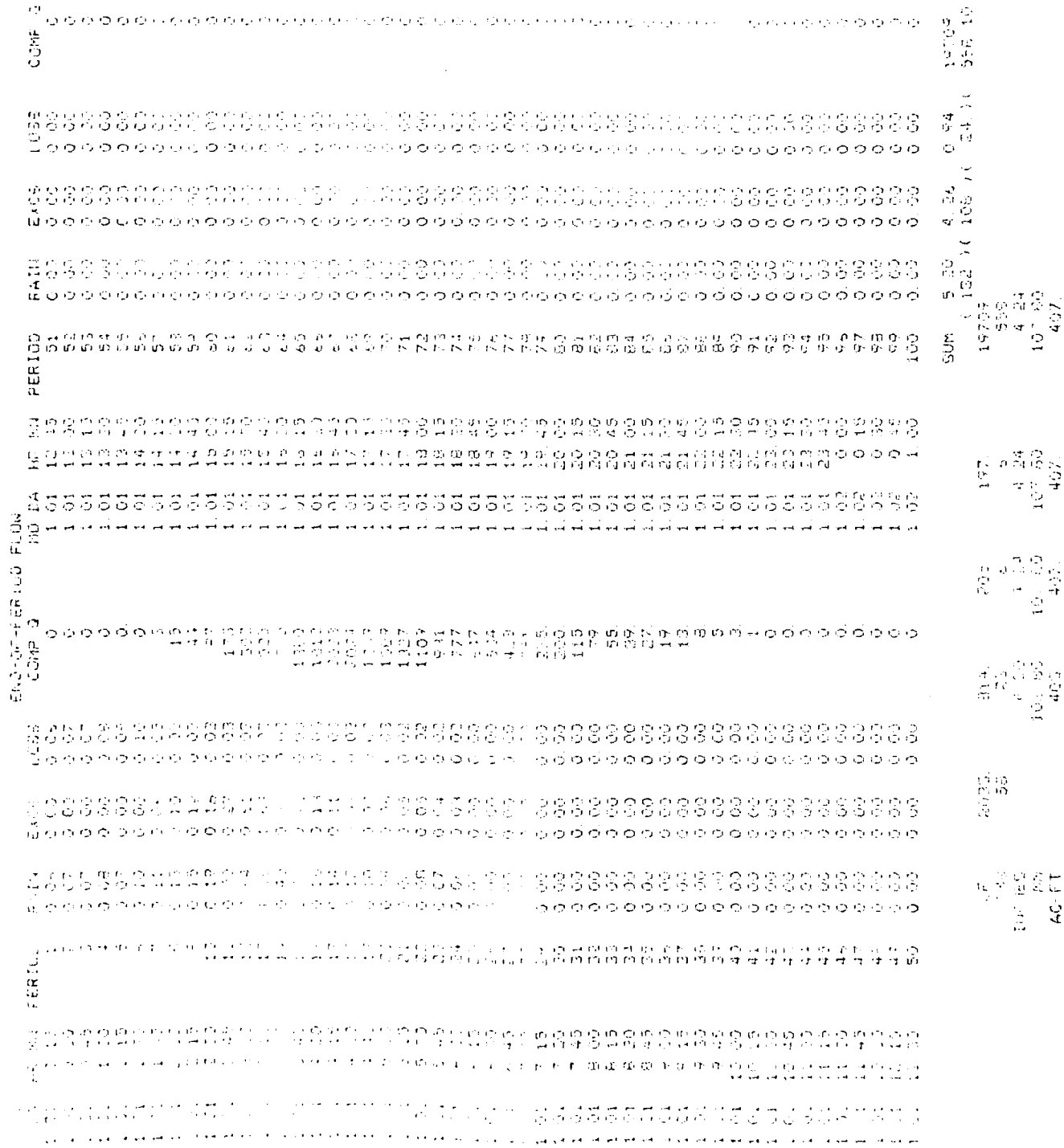

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SUBJECT _____

ROUTED FLOWS THROUGH RESERVOIR

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

GLOSS	CLOSS	AVS	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.0	1	1	0	3	0

STAGE	855.00	856.00	856.50	857.50	858.50	859.50	860.00	861.50
FLOW	0.00	61.00	112.00	299.00	1496.00	2446.00	4456.00	6140.00
STORAGE	0.	25	38	63	102	138	177	233
ELEVATIONS	855	856	857	858	859	860	861	862

CREL	SPWID	COQW	EXPW	FLEVL	COQL	CAREA	EXPL
855.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
865.5	0.0	0.0	0

END-OF-PERIOD HYDROGRAPH ORDINATES

MO	DA	HR	MN	PERIOD	RO/RS	INFLOW	OUTFLOW	STORAGE	ST/IS
1	01	0	15	1	0.25	0	0	0	855. 1
1	01	0	30	2	0.50	0	0	0	855. 1
1	01	0	45	3	0.75	0	0	0	855. 1
1	01	1	00	4	1.00	0	0	0	855. 1
1	01	1	15	5	1.25	0	0	0	855. 1
1	01	1	30	6	1.50	0	0	0	855. 1
1	01	1	45	7	1.75	0	0	0	855. 1
1	01	2	00	8	2.00	10	0	1	855. 1
1	01	2	15	9	2.25	44	1	3	855. 1
1	01	2	30	10	2.50	97	5	8	855. 1
1	01	2	45	11	2.75	178	12	15	855. 1
1	01	3	00	12	3.00	302	23	26	855. 1
1	01	3	15	13	3.25	533	43	47	855. 1
1	01	3	30	14	3.50	903	84	81	855. 1
1	01	3	45	15	3.75	1390	141	130	855. 1
1	01	4	00	16	4.00	1812	209	203	855. 1
1	01	4	15	17	4.25	2033	1325	89	855. 1
1	01	4	30	18	4.50	2054	1836	103	855. 1
1	01	4	45	19	4.75	1837	1796	105	855. 1
1	01	5	00	20	5.00	1584	1755	103	855. 1
1	01	5	15	21	5.25	1307	1608	89	855. 1
1	01	5	30	22	5.50	1109	1424	93	855. 1
1	01	5	45	23	5.75	911	1214	86	855. 1
1	01	6	00	24	6.00	777	1086	80	855. 1
1	01	6	15	25	6.25	647	893	75	855. 1
1	01	6	30	26	6.50	534	751	70	855. 1
1	01	6	45	27	6.75	428	647	66	855. 1
1	01	7	00	28	7.00	351	562	61	855. 1
1	01	7	15	29	7.25	275	476	57	855. 1
1	01	7	30	30	7.50	200	391	50	855. 1
1	01	7	45	31	7.75	115	319	46	855. 1
1	01	8	00	32	8.00	79	249	46	855. 1
1	01	8	15	33	8.25	58	183	42	855. 1
1	01	8	30	34	8.50	34	130	40	855. 1
1	01	8	45	35	8.75	21	91	38	855. 1
1	01	9	00	36	9.00	14	64	34	855. 1
1	01	9	15	37	9.25	12	44	31	855. 1
1	01	9	30	38	9.50	8	31	28	855. 1
1	01	9	45	39	9.75	5	24	25	855. 1
1	01	10	00	40	10.00	3	18	23	855. 1
1	01	10	15	41	10.25	1	13	21	855. 1
1	01	10	30	42	10.50	0	9	19	855. 1
1	01	10	45	43	10.75	0	6	17	855. 1
1	01	11	00	44	11.00	0	5	16	855. 1
1	01	11	15	45	11.25	0	4	15	855. 1
1	01	11	30	46	11.50	0	3	14	855. 1
1	01	11	45	47	11.75	0	2	13	855. 1
1	01	12	00	48	12.00	0	2	12	855. 1
1	01	12	15	49	12.25	0	1	11	855. 1
1	01	12	30	50	12.50	0	1	10	855. 1
1	01	12	45	51	12.75	0	1	10	855. 1
1	01	13	00	52	13.00	0	1	9	855. 1
1	01	13	15	53	13.25	0	1	9	855. 1
1	01	13	30	54	13.50	0	1	8	855. 1
1	01	13	45	55	13.75	0	1	8	855. 1
1	01	14	00	56	14.00	0	1	8	855. 1
1	01	14	15	57	14.25	0	1	7	855. 1
1	01	14	30	58	14.50	0	1	7	855. 1
1	01	14	45	59	14.75	0	1	7	855. 1
1	01	15	00	60	15.00	0	1	7	855. 1
1	01	15	15	61	15.25	0	1	7	855. 1
1	01	15	30	62	15.50	0	1	7	855. 1
1	01	15	45	63	15.75	0	1	7	855. 1
1	01	16	00	64	16.00	0	1	7	855. 1
1	01	16	15	65	16.25	0	1	7	855. 1
1	01	16	30	66	16.50	0	1	7	855. 1
1	01	16	45	67	16.75	0	1	7	855. 1
1	01	17	00	68	17.00	0	1	7	855. 1
1	01	17	15	69	17.25	0	1	7	855. 1
1	01	17	30	70	17.50	0	1	7	855. 1
1	01	17	45	71	17.75	0	1	7	855. 1
1	01	18	00	72	18.00	0	1	7	855. 1
1	01	18	15	73	18.25	0	1	7	855. 1
1	01	18	30	74	18.50	0	1	7	855. 1
1	01	18	45	75	18.75	0	1	7	855. 1
1	01	19	00	76	19.00	0	1	7	855. 1
1	01	19	15	77	19.25	0	1	7	855. 1
1	01	19	30	78	19.50	0	1	7	855. 1
1	01	19	45	79	19.75	0	1	7	855. 1
1	01	20	00	80	20.00	0	1	7	855. 1
1	01	20	15	81	20.25	0	1	7	855. 1
1	01	20	30	82	20.50	0	1	7	855. 1
1	01	20	45	83	20.75	0	1	7	855. 1
1	01	21	00	84	21.00	0	1	7	855. 1
1	01	21	15	85	21.25	0	1	7	855. 1
1	01	21	30	86	21.50	0	1	7	855. 1
1	01	21	45	87	21.75	0	1	7	855. 1
1	01	22	00	88	22.00	0	1	7	855. 1
1	01	22	15	89	22.25	0	1	7	855. 1
1	01	22	30	90	22.50	0	1	7	855. 1
1	01	22	45	91	22.75	0	1	7	855. 1
1	01	23	00	92	23.00	0	1	7	855. 1
1	01	23	15	93	23.25	0	1	7	855. 1
1	01	23	30	94	23.50	0	1	7	855. 1
1	01	23	45	95	23.75	0	1	7	855. 1
1	02	0	00	96	24.00	0	1	7	855. 1

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BY _____ DATE _____

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. _____ OF _____

PROJECT _____

1 01	13 45	70	13 75	0.	27	15	15	559
1 01	14 00	71	14 00	0.	14	14	14	559
1 01	14 15	72	14 25	0.	14	14	14	559
1 01	14 30	73	14 50	0.	13	13	13	559
1 01	14 45	74	14 75	0.	13	13	13	559
1 01	15 00	75	15 00	0.	12	12	12	559
1 01	15 15	76	15 25	0.	12	12	12	559
1 01	15 30	77	15 50	0.	12	12	12	559
1 01	15 45	78	15 75	0.	11	11	11	559
1 01	16 00	79	16 00	0.	11	11	11	559
1 01	16 15	80	16 25	0.	11	11	11	559
1 01	16 30	81	16 50	0.	10	10	10	559
1 01	16 45	82	16 75	0.	10	10	10	559
1 01	17 00	83	17 00	0.	10	10	10	559
1 01	17 15	84	17 25	0.	10	10	10	559
1 01	17 30	85	17 50	0.	10	10	10	559
1 01	17 45	86	17 75	0.	10	10	10	559
1 01	18 00	87	18 00	0.	10	10	10	559
1 01	18 15	88	18 25	0.	10	10	10	559
1 01	18 30	89	18 50	0.	10	10	10	559
1 01	18 45	90	18 75	0.	10	10	10	559
1 01	19 00	91	19 00	0.	10	10	10	559
1 01	19 15	92	19 25	0.	10	10	10	559
1 01	19 30	93	19 50	0.	10	10	10	559
1 01	19 45	94	19 75	0.	10	10	10	559
1 01	20 00	95	20 00	0.	10	10	10	559
1 01	20 15	96	20 25	0.	10	10	10	559
1 01	20 30	97	20 50	0.	10	10	10	559
1 01	20 45	98	20 75	0.	10	10	10	559
1 01	21 00	99	21 00	0.	10	10	10	559
1 01	21 15	100	21 25	0.	10	10	10	559
1 01	21 30	101	21 50	0.	10	10	10	559
1 01	21 45	102	21 75	0.	10	10	10	559
1 01	22 00	103	22 00	0.	10	10	10	559
1 01	22 15	104	22 25	0.	10	10	10	559
1 01	22 30	105	22 50	0.	10	10	10	559
1 01	22 45	106	22 75	0.	10	10	10	559
1 01	23 00	107	23 00	0.	10	10	10	559
1 01	23 15	108	23 25	0.	10	10	10	559
1 01	23 30	109	23 50	0.	10	10	10	559
1 01	23 45	110	23 75	0.	10	10	10	559
1 02	0 00	111	24 00	0.	10	10	10	559
1 02	0 15	112	24 25	0.	10	10	10	559
1 02	0 30	113	24 50	0.	10	10	10	559
1 02	0 45	114	24 75	0.	10	10	10	559
1 02	1 00	115	25 00	0.	10	10	10	559

[illegible]	1796 AT TIME	4 75 HOURS				
	CFS	1795.	745	505	196.	19-42
	CMS	51	21	5	6.	556
	INCHES		3 87	4 23	4 23	4 23
	MM		98 27	107 43	107 43	107 43
	AC-FT		[illegible]	[illegible]	[illegible]	206
	THOUS CU M		886	501	501.	501.

BY _____ DATE _____ **LOUIS BERGER & ASSOCIATES INC.** SHEET NO _____ OF _____

CHKD. BY _____ DATE _____ PROJECT _____

SUBJECT _____

RUNOFF SUMMARY: AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

HYDROGRAPH AT	1	2010	014	205	197.	1.50
		(57.50)(	23.34)(	5.81)(	5.58)(	4.66)
ROUTED TO	2	1196.	714.	205.	196.	1.00
		(30.68)(	21.23)(	5.79)(	5.56)(	4.66)

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	556.00	556.00	564.50
STORAGE	0.	0.	30.
OUTFLOW	0.	0.	113.

MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
558.58	2.08	105.	1796.	5.00	4.75	0.00